BRAided textiles to improve the **COMP**etitiveness of **CO**mposite materials industry in North-West Europe

Interreg North-West Europe COBRACOMP
European Regional Development Fund

Braided reinforcements for high performance composite materials

1st COBRACOMP online event

15 June 2021 • 13:00-14:15

EuraMaterials · University of Twente. · ensait Roubaix École d'Ingénieurs Textile · coexpair Composites Expertise for Aircraft · AGORIA · EUROCARBON advanced fibre braiding and weaving technology · CENTEXBEL · Collins Aerospace

Braided reinforcements for high performance composite materials

Webinar agenda (13:00-14:15)

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EUROPEAN UNION
European Regional Development Fund

1. Introduction to braiding technology - Stephan Voskamp, Eurocarbon
2. Braiding for composites turboprop blades - Pascal Amat, Collins aerospace
3. The COBRACOMP project: development of innovative braided reinforcements for high performance composite materials - Nicolas Martin, EuraMaterials
4. Question session with COBRACOMP partners

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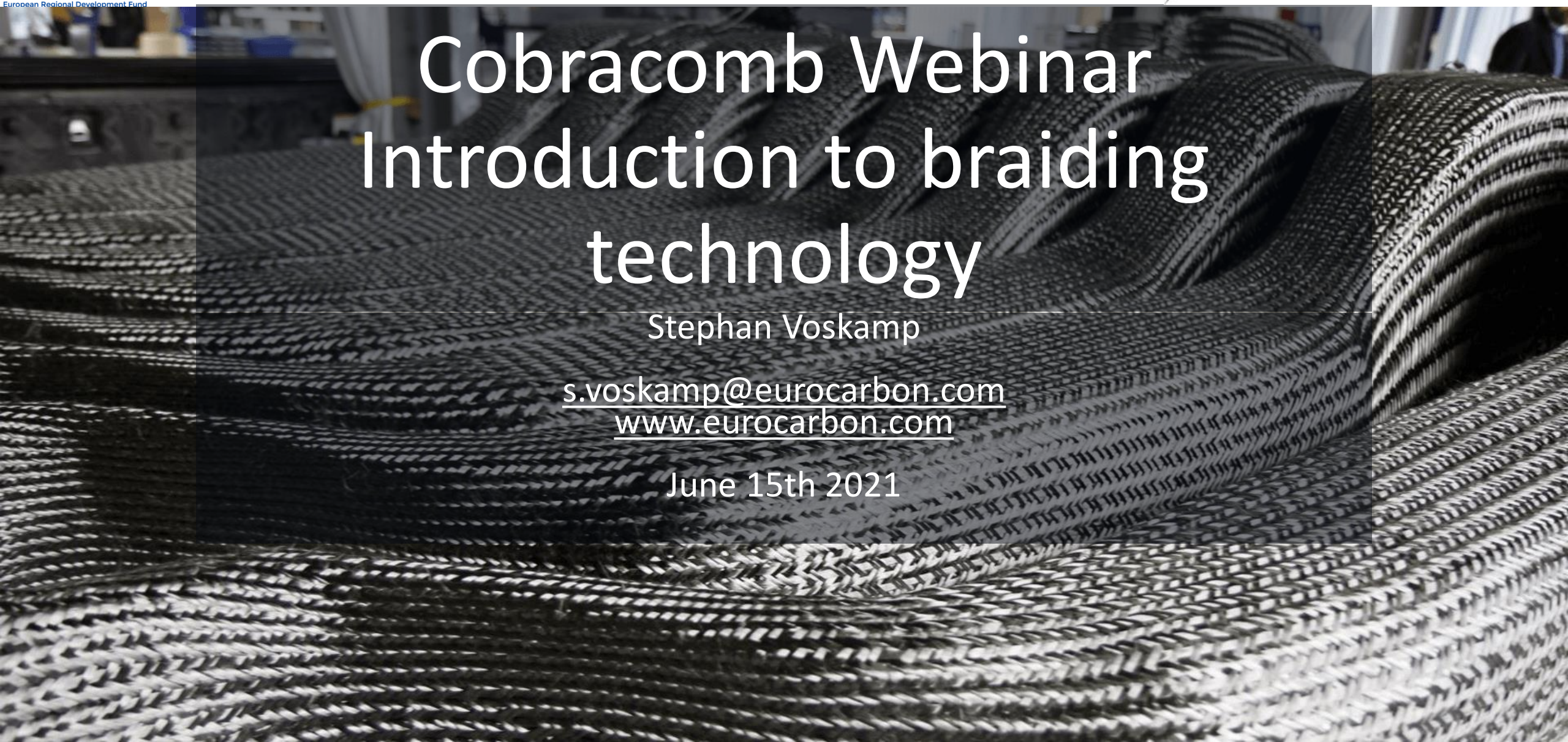
EUROCARBON
advanced fibre braiding and weaving technology



Cobracomb Webinar Introduction to braiding technology

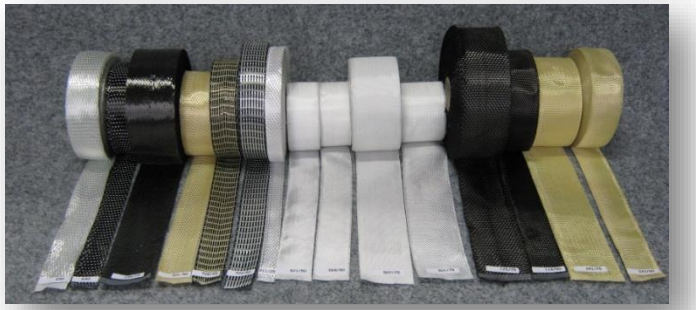
Stephan Voskamp

s.voskamp@eurocarbon.com
www.eurocarbon.com

June 15th 2021

Short introduction Eurocarbon

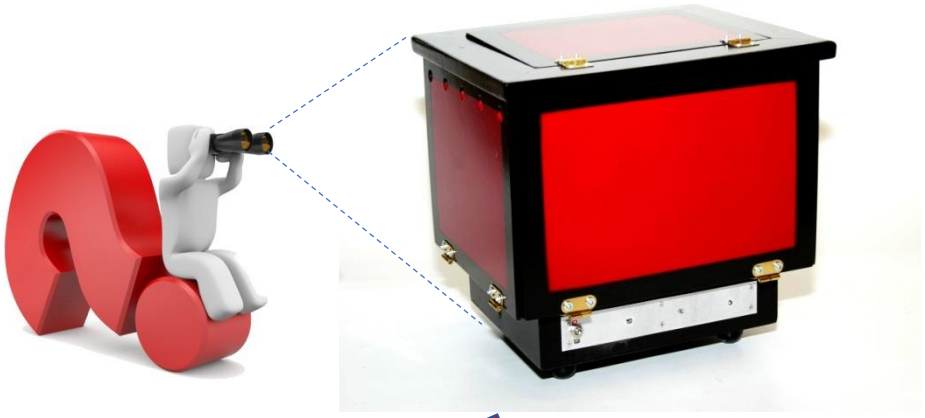
Eurocarbon was founded in 1982 and is one of the first companies to start braiding with carbon fiber. Since 1994 we started developing the overbraiding technique (automated preform production by braiding).



Overbraided series components in overbraiding are:

- **Mercedes McLaren SLR Crash cone**
- **Lamborghini Aventador A-pilar and Rocker**
- **BMW i8 A-Pilar (dev), Doorframe and Rocker**
- **BMW 7 Roof beam (between B pillars)**

The Trickbox



- Fabrics
- Filament winding
- Fiber placement
- ……

(Over)braiding?

Origin of braiding

- The first traces of mechanical braiding
  - Book by Georg Philipp Harsdörffer 1653
  - Invented in Utrecht (NL) source Wikipedia Gernany
- First patent on braiding machinery
  - Englishman Thomas Walford 1748

Source: German Wikipedia

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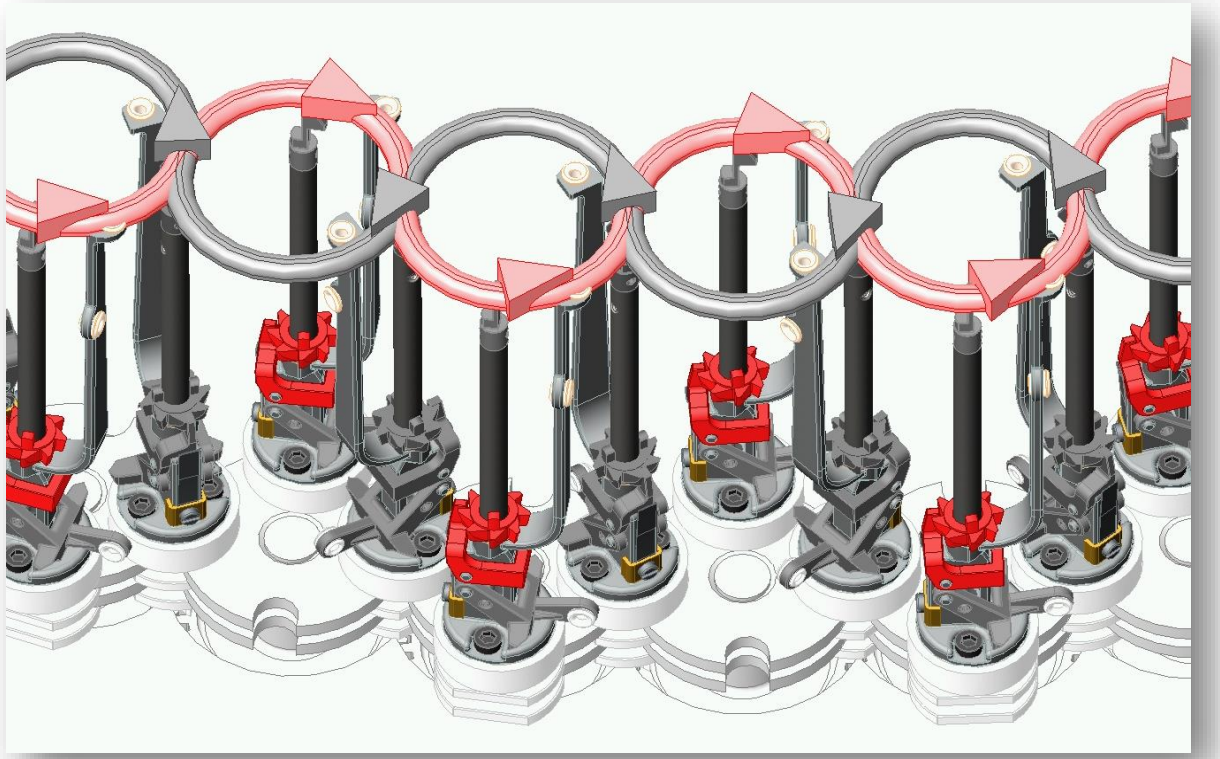
Braiding System



Continuous S motion: clockwise and counter clockwise

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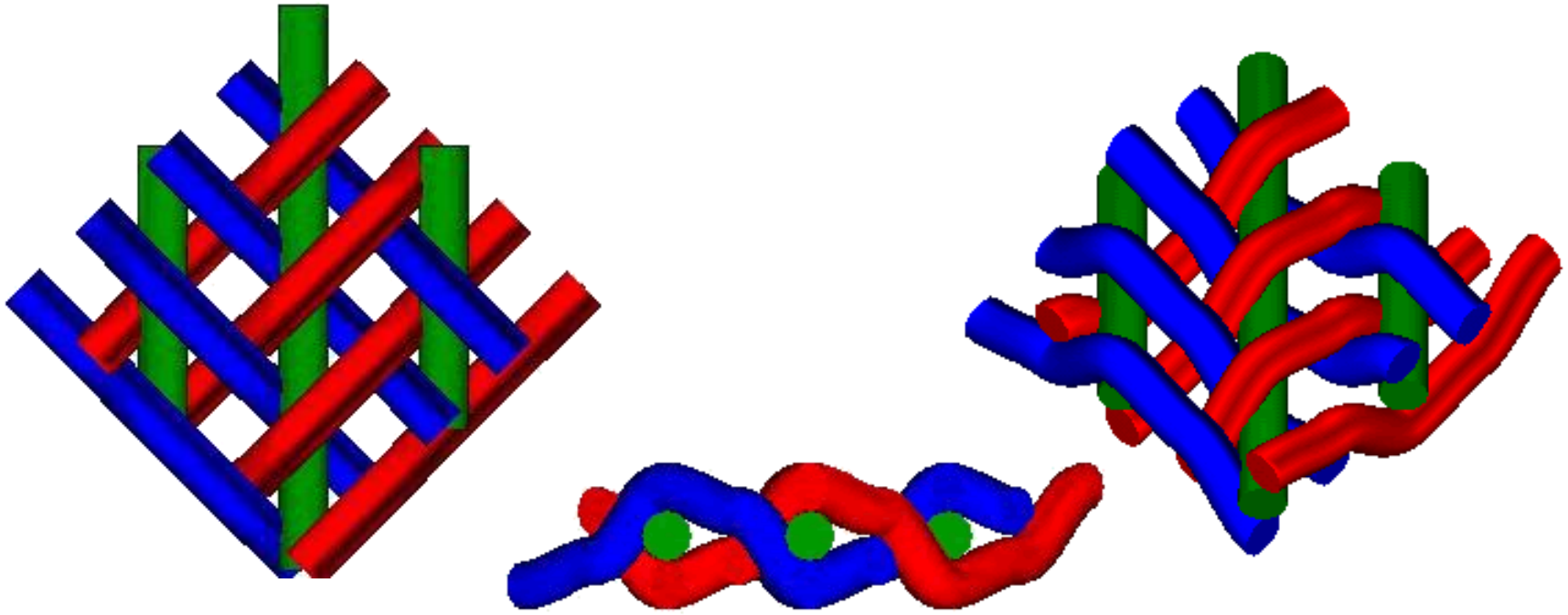
Braiding System

Continuous S motion: clockwise and counter clockwise

Braiding System



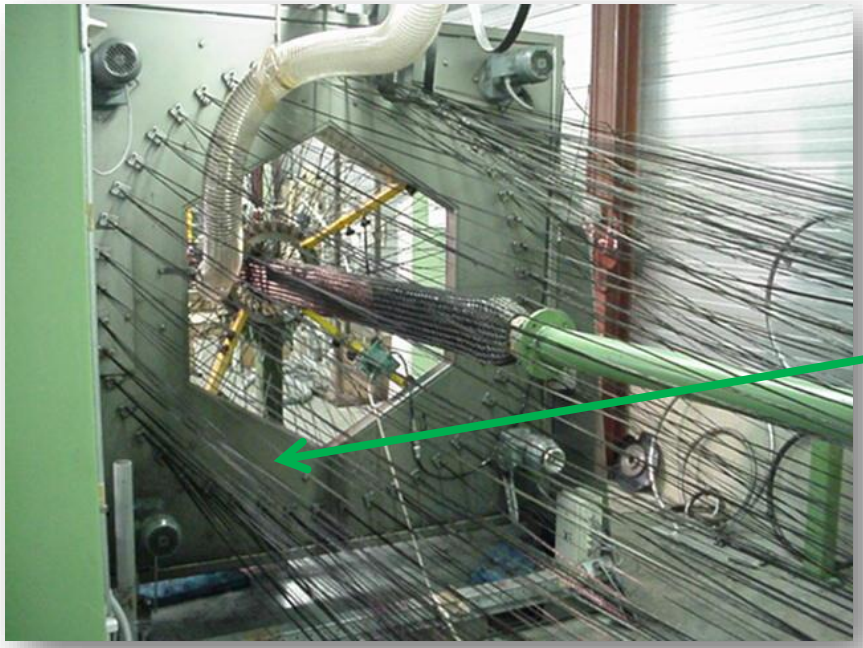
Curvature is exaggerated!!

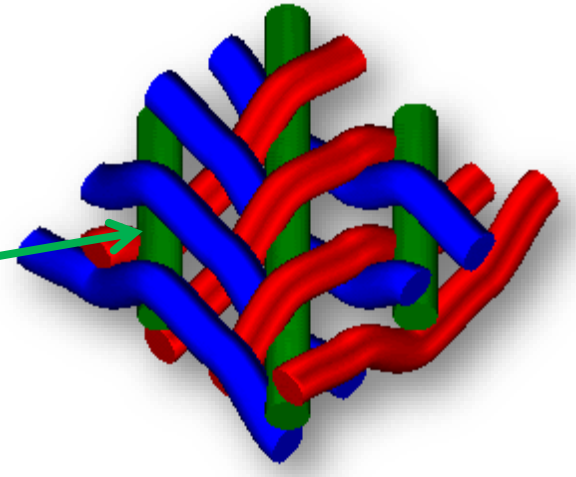
UD or 0º +45º -45º

Ratio in tows: 1 : 1 : 1

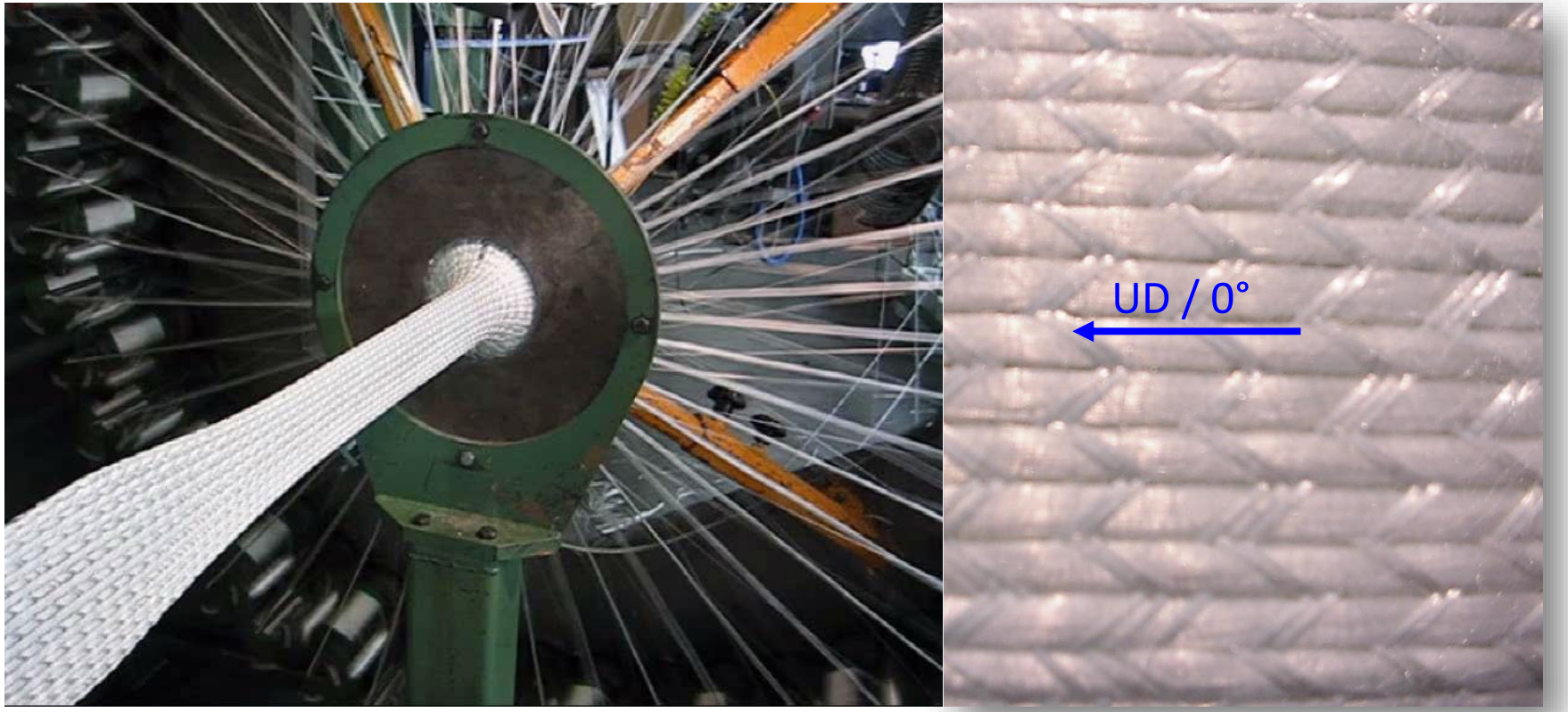
Tri-axial braids

- UD is effective in bending / compression
- Ratio Bias / UD can vary from f.i. 95/5 to 5/95 (weight)
- They come for ‘free’
- Freedom of selected positions and quantity
- Ratio UD positions to Bias positions is 2:1(positions)





High UD content tri-axial braid



Example of Bias / UD = 16% / 84%

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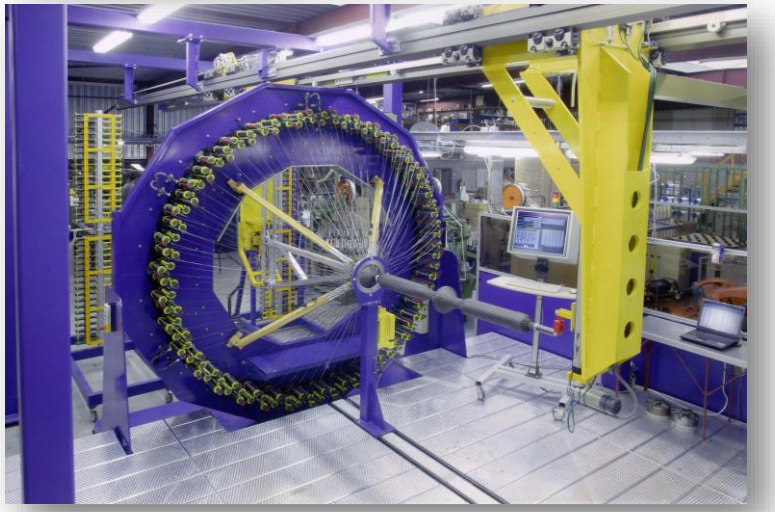
advanced fibre braiding and weaving technology

Why Overbraiding?

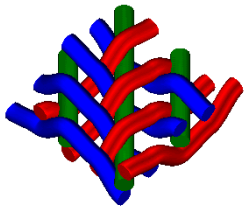
- **Fibres are directly placed onto the core**
- **Low waste rate <10% (direct fibre placement)**
- **Excellent crash properties (SLR crashcone)**
- **High degree of automation (high volume, large series)**
- **High deposition rate of fibres**
- **Used for load bearing applications (bending + torsion)**
- **Complex shapes are possible**



144 Carrier overbraider example

Advantages

- Curved components
- Braid angles can be programmed
- UD (bending) is integrated
- Tri-axial braid (torsion + bending)



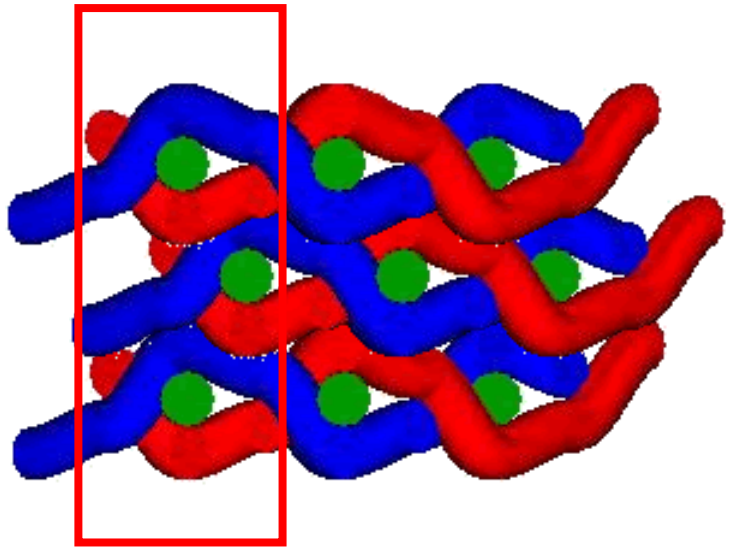
- UD or 0 °
- +45 °
- -45°

Compared to fabrics:

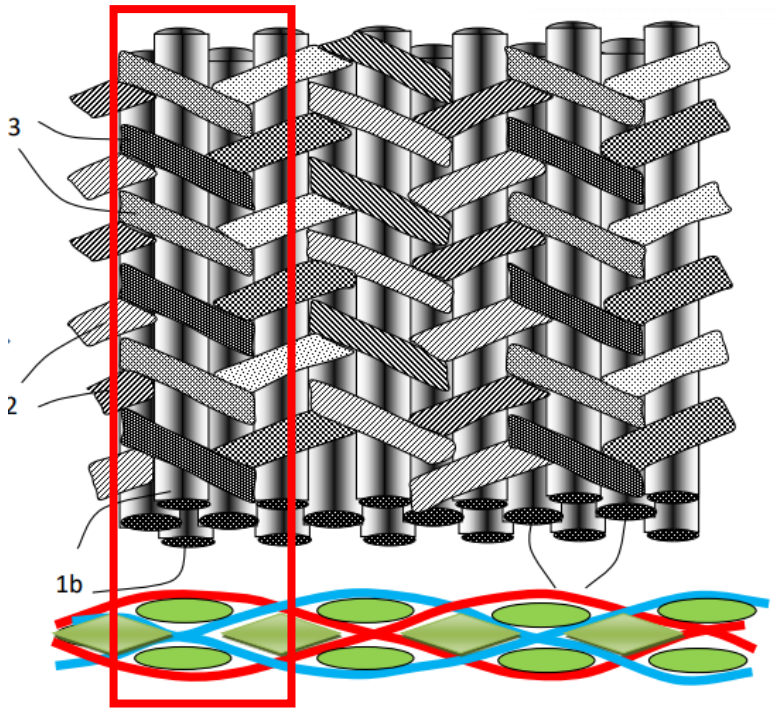
- No overlap
- No distortion of angles by folding
- UD is following core contour
- Automated process= less labor
- Significant less cutting waste
- Automated process = accuracy

The Cobracomb braids architecture

The architecture is invented by Mr. Georges Cahuzac (F)



Stacking 3 layers with nesting effect
3 UD yarns in selected region



Innovative braid structure with thickness binding

Cobracomb braid with thickness binding
4 UD yarns in selected region.
The central UD layer has 2 ends to match thickness

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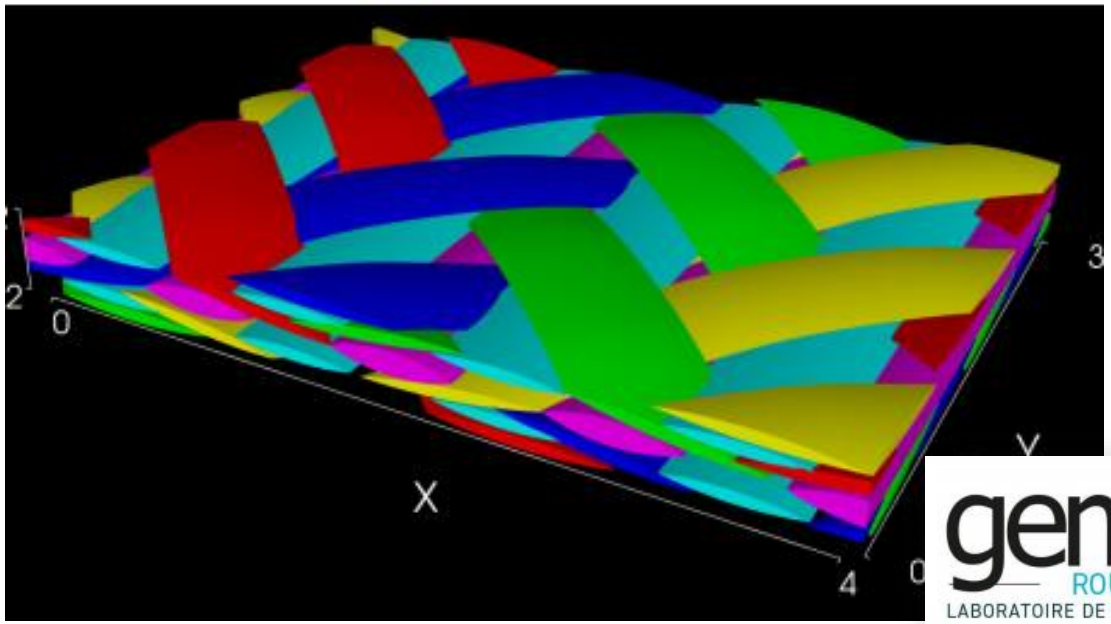
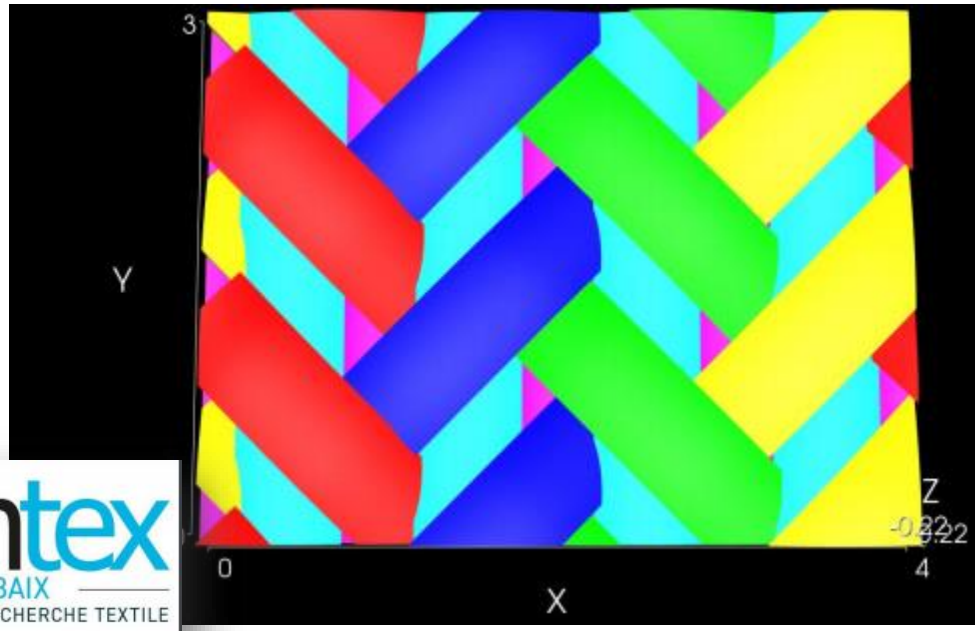
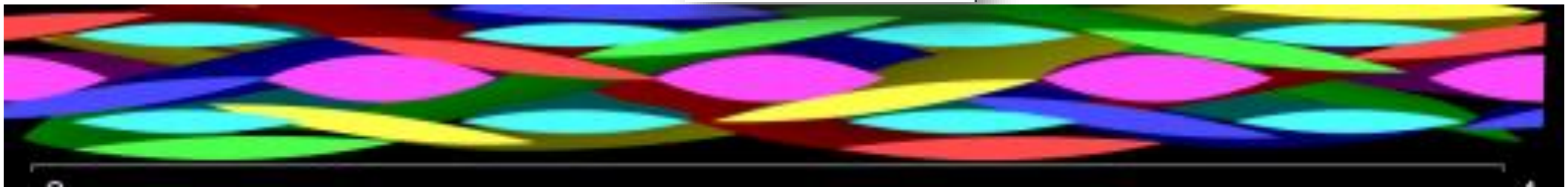
The Cobracomb braids architecture





gemtex
ROUBAIX
LABORATOIRE DE RECHERCHE TEXTILE



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Triaxial braiding
Mercedes McLaren SLR
Front Crash Cone

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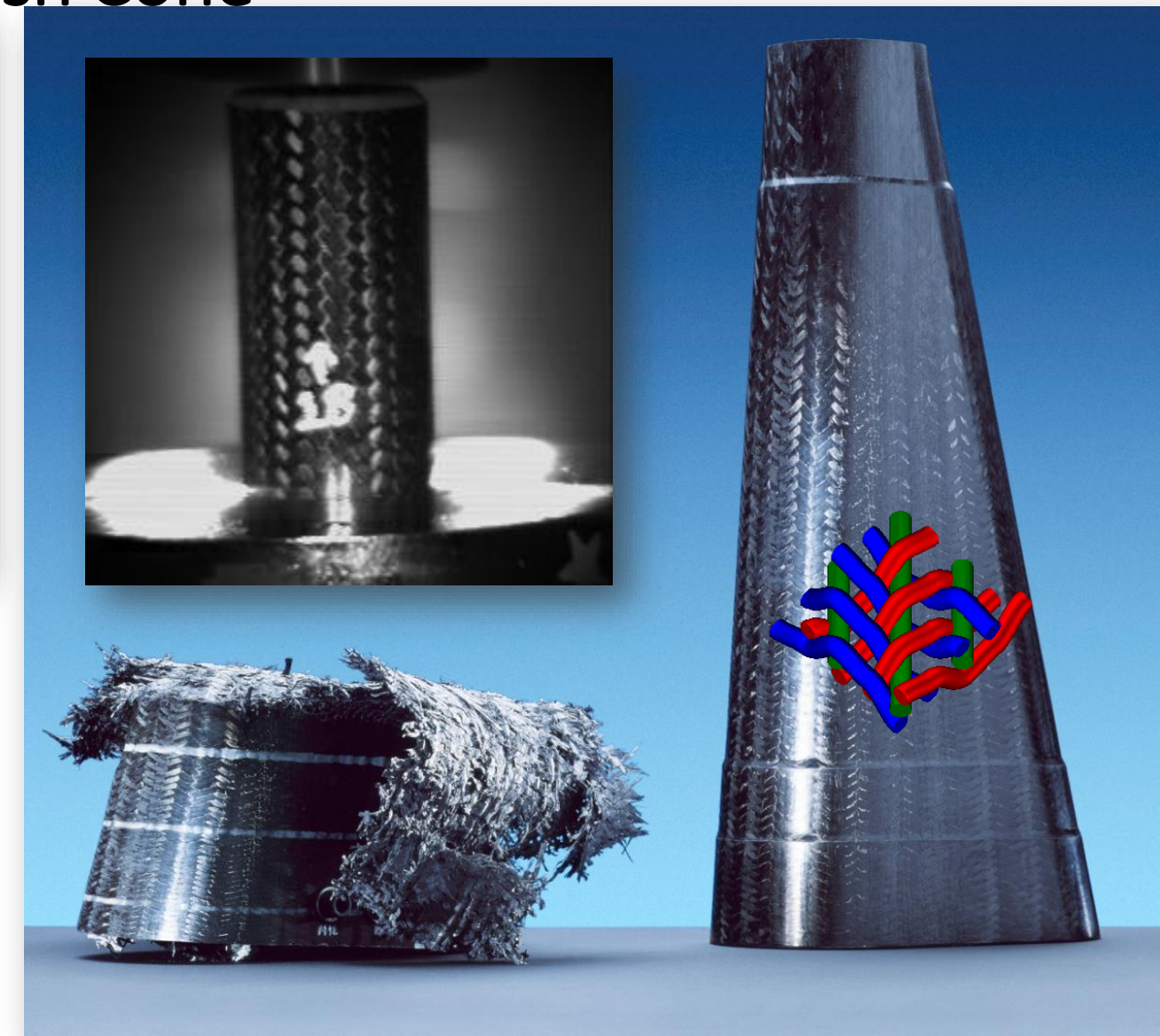

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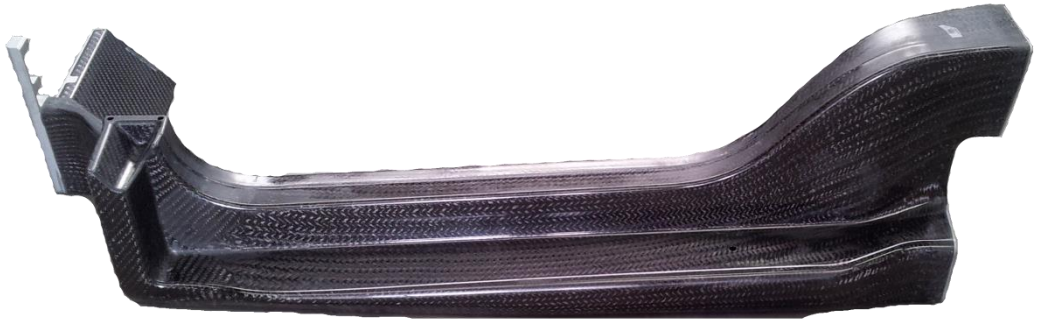
Triaxial braiding Lamborghini Aventador

- A-pilar
- A-pilar support bracket
- Rockers



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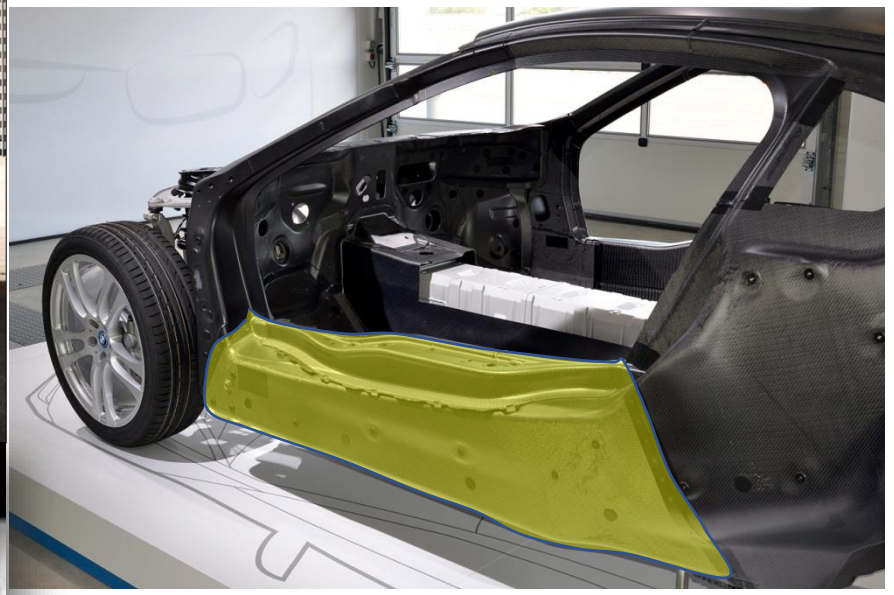
Triaxial braiding BMW i8



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Selection of braiders built

Braided textiles to improve the competitiveness of composite materials industry in North-West Europe

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COBRACOMP

COBRACOMP - WEBINAR

BRAIDING FOR TURBOPROP BLADES

JUNE 15TH 2021

Collins Aerospace

BRAIDING FOR TURBOPROP BLADES

SUMMARY

1. Presentation of Ratier-Figeac
2. RF Blades history
3. Why braiding process
4. RF Braiding machines
5. Why tri-axial braid - Why Cobracomp

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BRAIDING FOR TURBOPROP BLADES

RATIER-FIGEAC INTRODUCTION

Raytheon Technologies

Collins Aerospace

NET SALES $19 BILLION

Pratt & Whitney

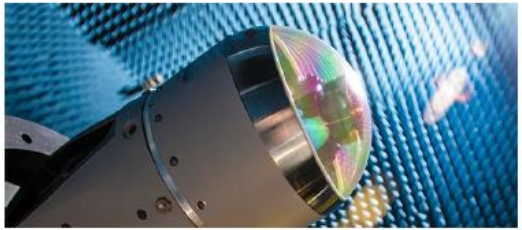
NET SALES $17 BILLION

Raytheon Intelligence & Space

NET SALES $11 BILLION

Raytheon Missiles & Defense

NET SALES $12 BILLION



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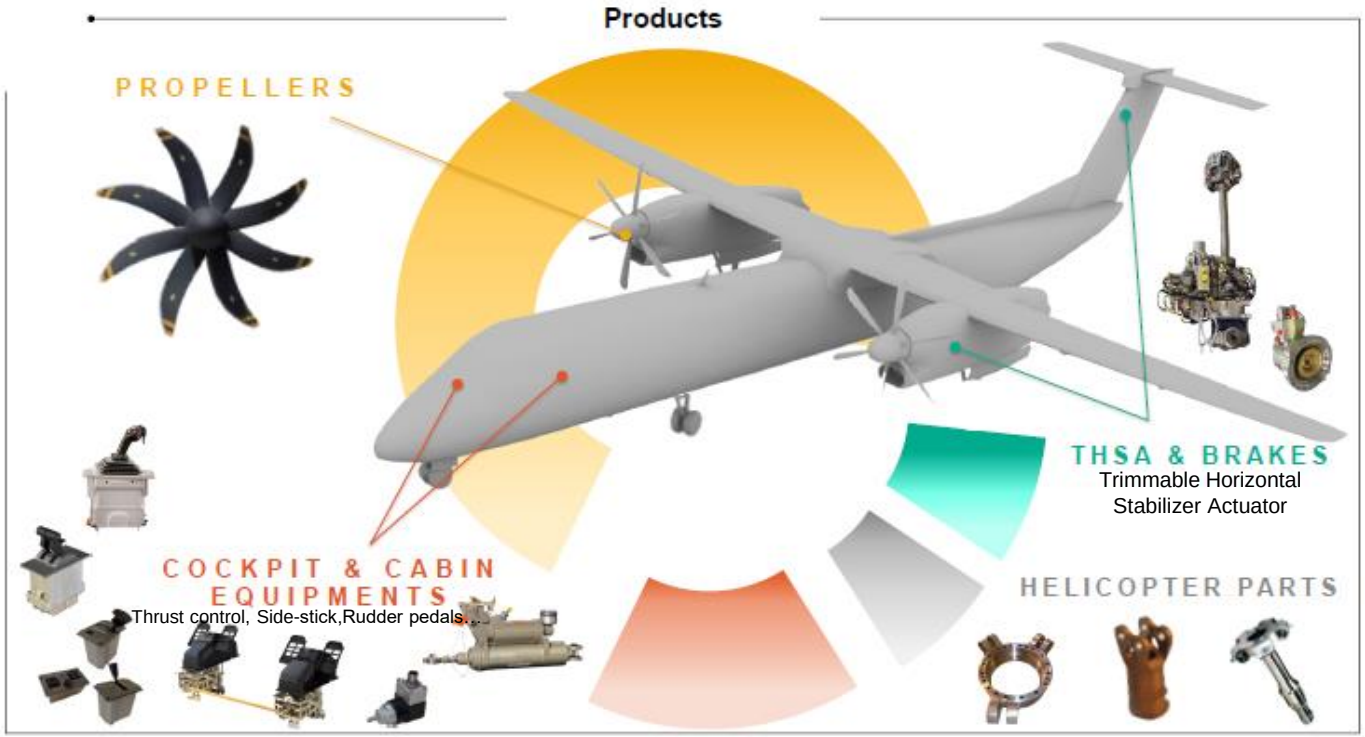
BRAIDING FOR TURBOPROP BLADES

RATIER-FIGEAC INTRODUCTION



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BRAIDING FOR TURBOPROP BLADES

BLADES HISTORY

DEVELOPPING, MANUFACTURING AND SERVICING PROPELLERS SINCE

1908

Strong position in both military and commercial applications

4, 6 and 8

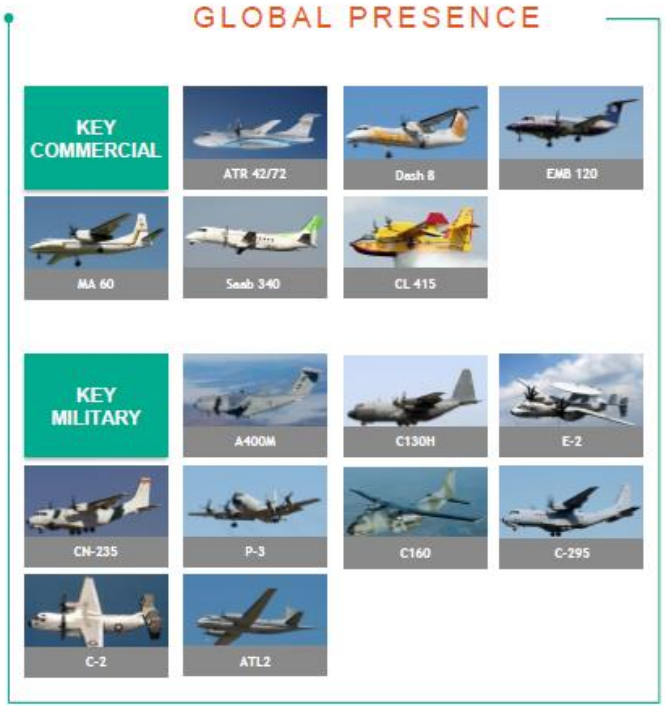
ALL-COMPOSITE / METALLIC BLADED PROPELLERS

PROPELLERS POWER RANGE

2000 to 11000 HP

BLADES / YEAR

≈ 2500



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BRAIDING FOR TURBOPROP BLADES

BLADES HISTORY

- RF's blades were initially in wood (1908) then in aluminum (1927) and progressively in composite using pre-impregnated (Transall, 1988)
- Advantages of composite vs aluminum
  - Blade weight divided by ≈ 2
  - Fatigue strength, damage tolerance, bird impact & corrosion strength improvement

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BRAIDING FOR TURBOPROP BLADES

BLADES HISTORY - WHY BRAIDING PROCESS

- In 1992 the braiding process is associated to the resin transfer molding (RTM) process to:
  - Reduce the cost & the lead time manufacturing
  - Improve the blade quality thanks to a repeatable process (semi-automatized)
- Examples of application:

ATR Propeller: dia ≈ 4 m / 6 blades

A400M Propeller: dia ≈ 5,3 m / 8 blades

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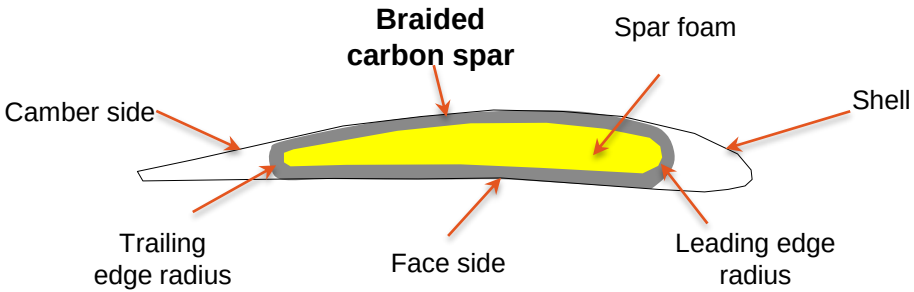
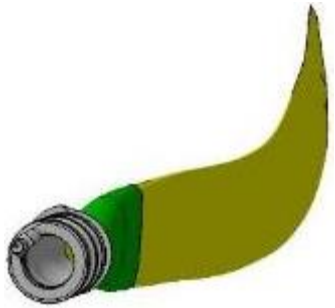
BRAIDING FOR TURBOPROP BLADES

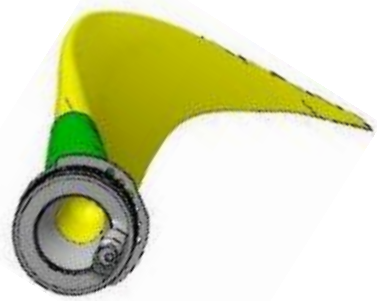
WHY BRAIDING PROCESS

- Typical design of a braided blade with fiber continuity in leading & trailing edges radii





Example of mandrel



- Specifities of a blade carbon spar
  - Complex shape including twist & sweep
  - Significant perimeter & thickness variations
  - Sharp radii in leading & trailing edges
  - The layup must include biais + uni-directional fibers

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BRAIDING FOR TURBOPROP BLADES

RF'S BRAIDING FACILITIES: 288&144 CARRIERS BRAIDING MACHINES

- 288 carriers braiding machines:
  - Updated for high power blades
  - Wheel dia ≈ 5,8 m
  - Handling robot: 6 dof + 1 translation for mandrel motion inside the guide ring

Two braiding machines required:

- One for bias fiber
- One for uni-directional fiber

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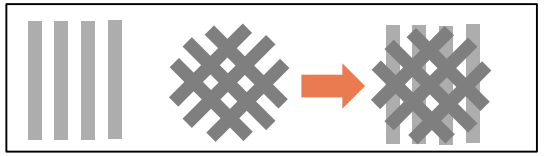
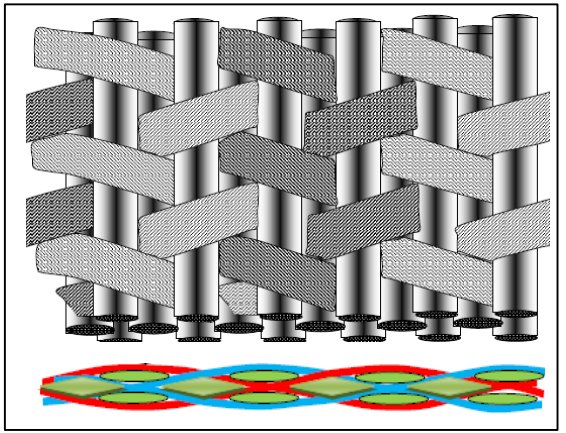
BRAIDING FOR TURBOPROP BLADES

WHY TRI-AXIAL BRAID - WHY COBRACOMP

- To use only one braiding machine for uni-directional and biais fibers
- To study the innovative tri-axial braid architecture from G. Cahuzac's patent
  - Surface distribution of the yarn more homogeneous (less waviness)
  - Higher fiber volume fraction capacity leading to higher mechanical properties
  - Braiding cycle reduction opportunity
- To development numerical tools for braiding simulation
  - Improved braid angle & thickness prediction for complex shapes

- Braiding automation opportunity => back and forth braiding





Innovative triaxial braid from G. Cahuzac

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Interreg
North-West Europe
COBRACOMP

EUROPEAN UNION

THANK YOU.

Collins Aerospace

BRAided textiles to improve the **COMP**etitiveness of **CO**mposite materials industry in North-West Europe

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European Regional Development Fund

The COBRACOMP project

Nicolas Martin, EuraMaterials

EuraMaterials · University of Twente. · ensait Roubaix École d'Ingénieurs Textile · coexpair Composites Expertise for Aircraft · AGORIA · EUROCARBON advanced fibre braiding and weaving technology · CENTEXBEL · Collins Aerospace

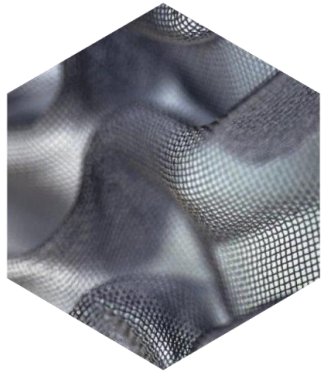
Outline of the presentation

1. EuraMaterials
2. COBRACOMP in brief
3. The Interreg NWE programme
4. Partnership
5. Workplan
6. Timeline and events to come
7. To know more…

EuraMaterials

Cluster of materials processing industries

Interreg North-West Europe COBRACOMP
European Regional Development Fund



textiles

composites

plastics

ceramics

glass

wood

paper/carboard

metal

...

FACILITATE INNOVATION

GENERATE OPPORTUNITIES

INSPIRE TRANSFORMATION

PROMOTE CREATION

NETWORKING

CERTIFICATIONS

LES PÔLES DE COMPÉTITIVITÉ
MOTEURS DE CROISSANCE ET D'EMPLOI

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RetiS
Réseau français de l'innovation

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Liberté
Égalité
Fraternité

Région Hauts-de-France

MEL MÉTROPOLE EUROPÉENNE DE LILLE

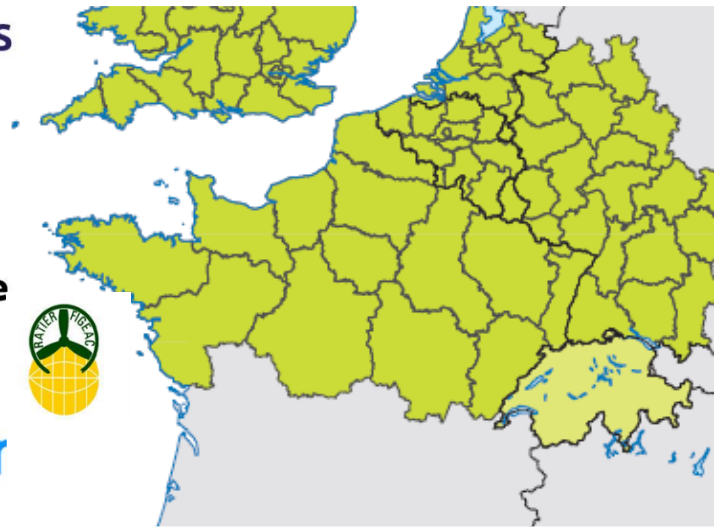
CAPSO

The COBRACOMP Project – The project in brief

Interreg North-West Europe COBRACOMP
European Regional Development Fund

- **A north-west Europe cooperation of key leaders of the composite materials value chain: academia, industry, clusters**

Leader: EuraMaterials
Timeline: 2019-2023
8 partners in BE, FR, NL
Total Budget: 3,54 M€
EU Funding: 2,12 M€

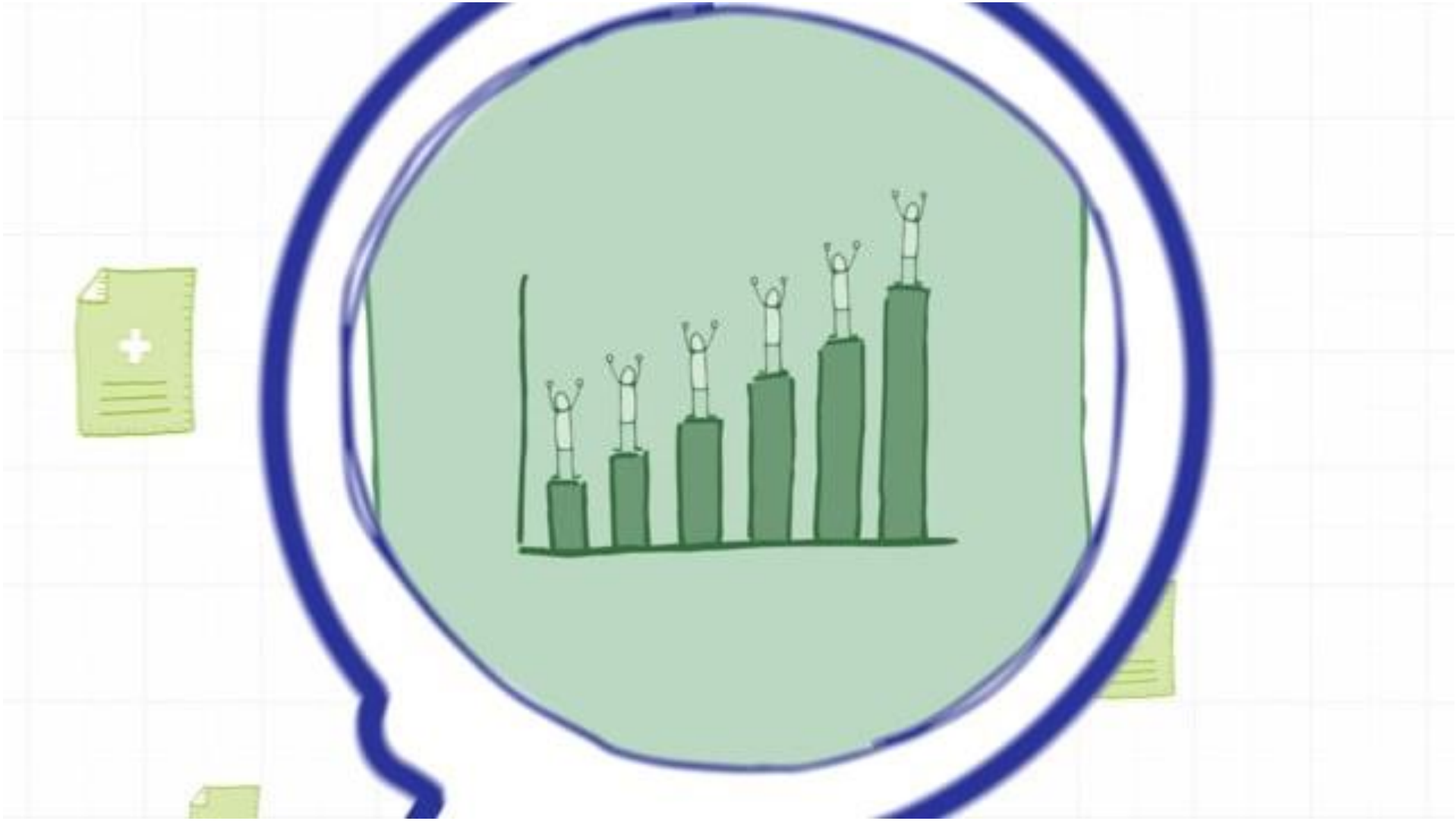


The main objectives of the project:

- Develop braiding machines to manufacture innovative multilayer 3D triaxial braids
- Develop numerical simulation tools to predict braid geometry and mechanical properties
- Manufacture and test composite materials reinforced with the braided reinforcements
- Demonstrate the technology in relevant conditions with demonstrators
- Disseminate the project results : workshops, community dedicated to braided composites

The COBRACOMP Project

The Interreg North-West Europe programme



The COBRACOMP Project – The partnership

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European Regional Development Fund

Clusters and industry federation

EuraMaterials

FR, Cluster of the materials processing industries.
Project leader

AGORIA

BE, Belgian federation of the technological industry

Academia and technologies centres

UNIVERSITY OF TWENTE.

NL, Composites engineering institute

ensait ROUBAIX ECOLE D'INGENIEURS TEXTILE

FR, Textile engineering institute

CENTEXBEL

BE. Technical center of the Belgian textile industry

Industry value chain

EUROCARBON advanced fibre braiding and weaving technology

NL. Producer of renforcements for CM

coexpair Composites Expertise for Aircraft

BE. Manufacturer of RTM equipments for CM processing

Collins Aerospace

FR. Leading supplier of composites propeller systems

Associated partners

CLUBTEX

Skywin Aerospace cluster of Wallonia

CompositesNL

Fedustria

EuCIA

The COBRACOMP Project – Project workplan

Interreg North-West Europe COBRACOMP
European Regional Development Fund

WP M. Project management — EuraMaterials

WP C. Communication — EuraMaterials

WP LT. Long-term effects — .AGORIA

WP1 Development and testing of the technology

CENTEXBEL

New braiding process

- Design and engineering of a new machine
- Numerical tools (process and materials)
- Composite materials processing (RTM) & testing

Braiding machine and composite materials properties assessment

WP2 Validation of the technology

Collins Aerospace

Technology demonstrator

- Design and engineering
- Preforms manufacturing
- RTM processing
- Testing of the demonstrator

Manufacturing and performance assessment on a composite part

WP3 Dissemination to enterprises

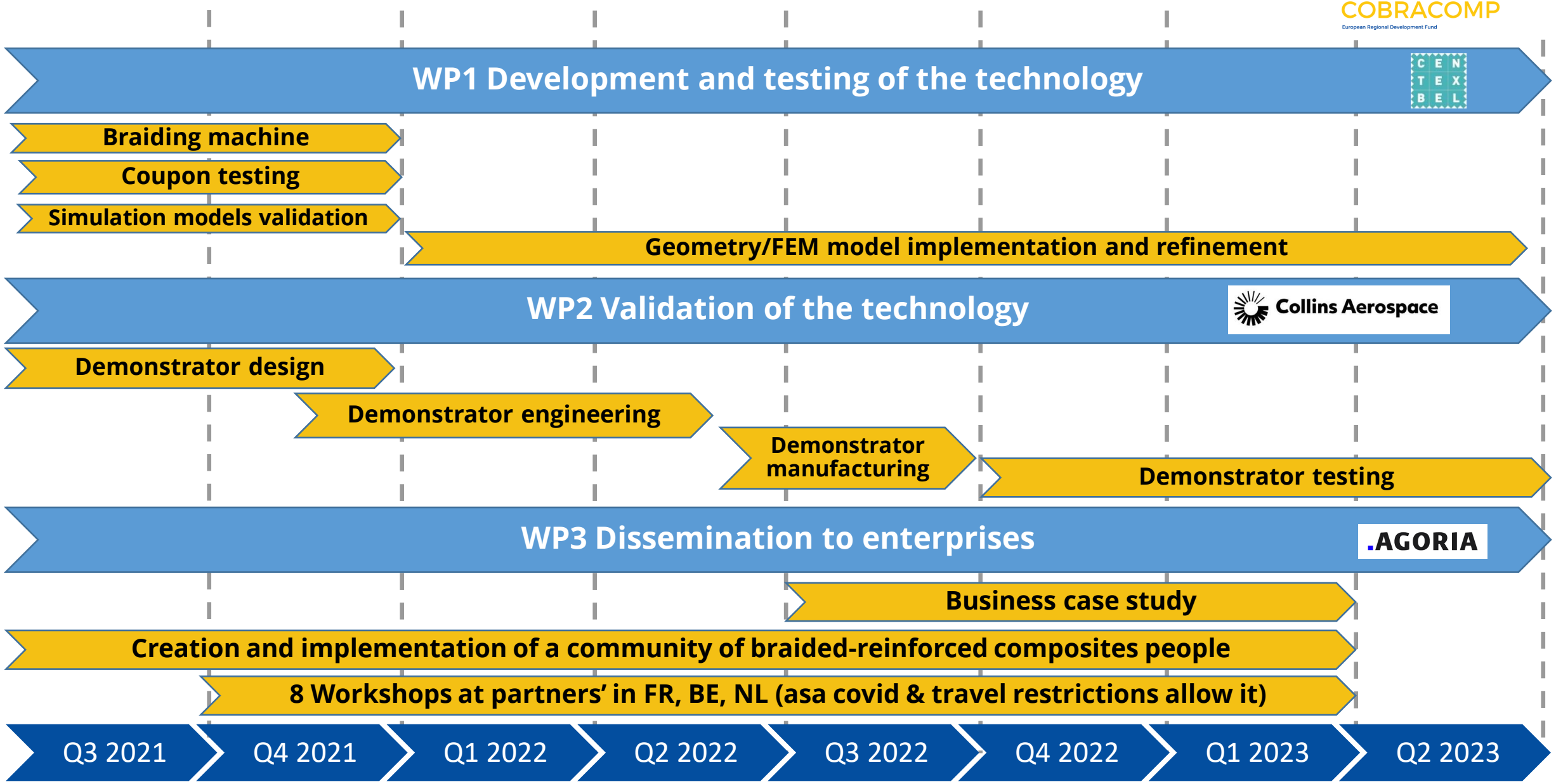
.AGORIA

Showcase of the technology

- Case study analysis
- Workshops/open days to support enterprises
- Create a community dedicated to braided composites

Foster project results roll-out and uptake by the composites value chain

The COBRACOMP Project – Timeline (covid-dependent)



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End

The COBRACOMP Project – To know more....

- On our website: www.nweurope.eu/cobracomp
- On linkedin: https://www.linkedin.com/company/interreg-nwe-cobracomp
- Contact project partners

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Agoria	Kevin Poelmans	kevin.poelmans@agoria.be
Collins aerospace /Ratier-Figeac	Pascal Amat	pascal.amat@ratier-figeac.fr

QUESTION SESSION to the partnership

.AGORIA

CENTEXBEL

coexpair
Composites Expertise for Aircraft

Collins Aerospace

EuraMaterials

EUROCARBON
advanced fibre braiding and weaving technology

ensait
ROUBAIX
ECOLE D'INGENIEURS TEXTILE

UNIVERSITY OF TWENTE.

BRAided textiles to improve the **COMP**etitiveness of **CO**mposite materials industry in North-West Europe

Interreg North-West Europe COBRACOMP
European Regional Development Fund

Braided reinforcements for high performance composite materials

1st COBRACOMP online event

15 June 2021 • 13:00-14:15

Thank you very much !

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